



# Novel Fog-Removing Method For The Traffic Monitoring Image

**SAFOORA NOUSHEEN**  
 M.TECH Student, Dept of ECE  
 Kakatiya Institute of Technology &science  
 Warangal-506015, Telangana, India.

**S.PRADEEP KUMAR**  
 Assistant Professor, Dept of ECE  
 Kakatiya Institute of Technology &science  
 Warangal-506015, Telangana, India.

**Abstract**— In this paper, we proposed a novel fog-removing method in order to make the images becoming more clear and more easy to recognition. In human lives images have an important role. To analyze traffic, satellite images are used, in developed cities traffic analysis is done through CCTV cameras. Images captured under bad weather conditions suffer low contrast so their quality degrades with the changes in atmosphere. The main reason behind the image degradation is atmospheric scattering, which is light received from scene points while capturing an image, is absorbed and scattered by a complex medium which includes fog, mist and haze. The proposed method combines the Retinex algorithm and wavelet transform algorithm. The proposed method firstly use Retinex algorithm to enhance the image, then the wavelet transform is used to enhance the details of the image. We determine PSNR(Peak signal –to-noise Ratio),of images which are processed by our proposed method have the PSNR values higher than the traditional Retinex algorithm's.

**Keywords**—Foggy Image; Retinex Algorithm; Wavelet Transform;PSNR

## I. INTRODUCTION

Weather became very serious in all countries. This kind of common weather phenomena will produce whitening effect, will cause the image to degenerate, even fuzzy, which will bring the serious influence for the transportation system and the outdoors vision system. Therefore there is a new requirement to deal with to fog image clarity and realistic. With the continuous development of computer hardware and software technology, it became possible to remove fog from the massive images. Nowadays, there are several representative algorithms for fog-removing proposal. They can be divided into the following:

### *The global image contrast enhancement method :*

Global fog image enhancement method refers to the adjustment of the grey value is determined by the statistical information of whole fog image. There has no any relation with the adjustment point of the region. Such as Brian Eriksson [1] take advantage of the curvelet transform to automatic remove fog using the vanishing point detection based on curvelet. But the disadvantage of the algorithm is only relative to improve the quality of images, not in the true sense of removing fog from image. Retinex algorithm [2, 3] is a model describing the color invariance, it has the characteristics of dynamic range compression and color invariance, caused by uneven illumination and low contrast color image has very good effect. Retinex has taken the great attention by researchers in recent years, including Single Scale Retinex algorithm (Single Scale Retinex, SSR)[2] and multiscale Retinex algorithm (Multi-scale Retinex, MSR)[3] application has achieved great success.

### *Image restoration based on prior information:*

Many researchers focus on how to solve completely removing fog for signal image according to the variation in the fog concentration. In this early work was done by Tan [6]. Moreover, Fattal [7] and others under the assumption that the transmission of light is local not related with and the scene target surface shading part, to estimate the scene irradiance, and thus derived the propagation image. In this paper an improved fog removing method for the traffic monitoring image, which combining Retinex algorithm and wavelet transform is proposed. The proposed method firstly use Retinex algorithm to enhance the image, then the wavelet transform is used to enhance the details of the image, finally a cleared image which are removed fog can be obtained after reduce the none-important coefficients. The proposed method can effectively remove fog from the image taken in heavy fog weather. The estimation showed that it is better than the traditional algorithms such as Retinex algorithm [2, 3] and Dark grey prior [8].

## II. RELATED WORK

### *Color Image Enhancement Methods*

When the illumination conditions are poor in the scene, then the image representation in the human observers eye and captured images digital representation never matches with each other [6].The images appear darker due to low contrast. The low contrast images are needed to be enhanced. Different methods are used to increase the contrast of the images. These contrast enhancement techniques increase the contrast of images and increases its quality.

Two methods for contrast enhancement are global and adaptive methods [3].A transformation is made

on all pixels of the image in global method of contrast enhancement. Histogram equalization and linear contrast stretching are examples of global method. An input, output transformation is applied to the image in the adaptive method of contrast enhancement. It changes adaptively with the properties of the image.

Adaptive histogram equalization is the example of an adaptive method of contrast enhancement. The dynamic range of an image is stretched using the contrast stretching technique [7] to improve the contrast. The dynamic range is the range between the minimum intensity value and the maximum intensity value. It is mainly used to increase contrast of medical images.

Histogram Equalization (HE) [8] is another method of contrast enhancement. It uses the histogram of the image to adjust its contrast. It analyzes the number of pixels and they are spread evenly over the available frequencies to give an equalized image. If Histogram Equalization (HE) is applied directly on color image, it changes the properties of color channel which changes the color balance of the image. So HE should be applied to luminance or value by converting the image into LAB color space or HSV color space. So the hue and saturation of the image does not change.

Adaptive Histogram Equalization (AHE) is a type of Histogram Equalization, which uses an adaptive contrast enhancement technique. It computes many histograms, related to a distinct part of the image. The lightness values are redistributed using them. The local contrast of the image is increased by this method.

Homomorphic filtering [8] increases the contrast of an image by normalizing its contrast. It removes the multiplicative noise. Illumination variations are considered as multiplicative noise. Homomorphic filter is a high pass filter which passes the reflectance which is in the high frequency part and removes illumination variations which is in low frequency part. Thus the illumination variations which are a type of multiplicative noise can be reduced by using homomorphic filtering.

The two problems of image captured by camera due to limitations of lighting conditions of the scene are dynamic range problem and color constancy problem. The dynamic range problem is the loss of color and details in the shadowed areas of the image. When the illuminant has variations in the spectral distributions which is caused due to difference in daylight and artificial light by the camera, the distortions of color occurs in the image. It is the problem of color constancy.

The problem called color rendition occur in color images, when the processed image is matched with the observed image. It occurs as a result of halo artifacts and gray world assumption violations. These problems can be reduced using Retinex

algorithms. Retinex algorithms improve the color rendition, dynamic range compression, and color constancy of the digital image.

### Challenges Faced by Color Image Enhancement Methods

The contrast stretching stretches the dynamic range of image. It provides good visual representation of the original scene, but some of the detail may be loss due to clipping, poor visibility in under exposure regions of the image. The color constancy cannot be achieved by this algorithm. The homomorphic filtering is a high pass filter that removes the multiplicative noise. But it results in bleaching of the image. AHE has a tendency to over amplify the noise in relatively homogeneous regions of the image. so we use retinex algorithm in our proposed method.

## III. PROPOSED METHOD

### Retinex Algorithm

The Retinex image enhancement algorithm is an image enhancement method that enhances an image with dynamic range compression. It also provides color constancy. It gives a computational human vision model. It deals separates two parameters. At first the illumination information is estimated and then the reflectance is obtained from using division. It is based on the image formation model which is given [1] by

$$I(x, y) = L(x, y) r(x, y) \quad (1)$$

Where I is the input image, L is illumination and r is reflectance. The image is first converted into the logarithmic domain [1] in which multiplications and divisions are converted to additions and subtractions that makes the calculation simple. The sensitivity of human vision reaches a logarithmic curve. The flowchart of Retinex algorithm is shown in the Fig 1. Here S is the input image. The illumination is estimated

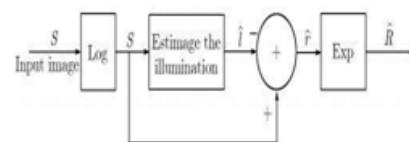


Fig.-1: General Flowchart of Retinex Algorithm

The Retinex enhancement algorithms can be applied on all pictures. It provides better dynamic range compression and color rendition. It is an automatic process independent of inputs.

### Single scale Retinex Algorithm:

Retinex algorithm [2, 3] has showed good effect on removing fog from image. Retinex algorithm is to reduce the effects of incident light on the image, and to strengthen the reflection image as follows: It is given by

$$R_i(x, y) = \log I_i(x, y) - \log [ \hat{F}(x, y) * I_i(x, y) ]$$

$$R_i(x, y) = \log \frac{I_i(x, y)}{\hat{F}(x, y) * I_i(x, y)} = \log \frac{I_i(x, y)}{\hat{F}(x, y)} \quad (2)$$

Where  $i=1,2,\dots,s$

$I_i(x,y)$ : The image distribution in the  $i^{\text{th}}$  spectral band

$R_i(x,y)$ : Retinex output

Gaussian function:  $F(x,y)=Ke^{-(x^2+y^2)/c^2}$

K is Normalization factor selection of K such that

$$\iint F(x,y) dx dy = 1$$

'C' is the Gaussian surround space constant.

The parameter 'C' controls center/surround function range, the value is smaller, the center/surround function is sharper.

**Multi Scale Retinex Algorithm (MSR):**

Multi Scale Retinex (MSR) is developed to combine the strength of different surround spaces. The Gaussian filters of different sizes are used to process input image several times. The resulting images are weighted and summed to get output of MSR. It is given by

$$R_{MSR} = \sum_{n=1}^N \omega_n [\log I(x,y) - \log [F_n(x,y) * I(x,y)]] \quad (3)$$

Where  $i=1, 2, 3,\dots,S$ . Here,  $\omega_n$  weight associated with  $n^{\text{th}}$  Scale. N is number of scales. MSR provide color enhancement. It also provides dynamic range compression and tonal rendition. The halos are reduced by using MSR.

**The wavelet Transform:**

In these paper, methods of image enhancement based on wavelet transform were proposed. However, we cannot obtain more high-frequency information only through multi-scale wavelet transform. An image's different scale detail information can be obtained through wavelet transform, but there will be some high-frequency information hidden in high-frequency sub-images of wavelet transform.

2-D discrete wavelet transform algorithm is a well-known method for image processing. It use high-pass filter and lowpass filter two times respectively at horizontal and vertical direction, the decomposition results are as follows: the approximate component A, the level of detail components H, vertical detail coefficients V and diagonal detail component D. Approximate coefficients represent the background picture which has the lowest frequency, detail coefficient represents the scene information which has the high frequency.

**IV. IMPLEMENTATION**

We have collected the sunny-day image and the fog-day image which are taken in same place and in same camera angle from Internet. The total images are about fourth (twenty for sunny day, twenty for fog-day). The most of these images are about traffic, vehicle and etc. Each image was 420x276 pixels. Experiments were carried out on

is-2410M processor with the system bus being 2.3GHz and the main memory being 4G. MATLAB2.0 was used for development. We used two traditional algorithms: Retinex[2,3] and Dark channel algorithm [8], to make the comparison with the proposed R+WT method.

**V. RESULTS**

Two experimental result sets are picked up for discussion which is showed in Fig.1 and Fig.2. In Fig.1, (a) shows a Sunny day image ; (b) shows the fog day which was taken in the same place and in the same camera angle with (a);(c) shows the image which is processed by Dark Channel algorithm. (d) shows the image which is processed by Retinex method; (e) shows the image which is obtained by using R +WT method.

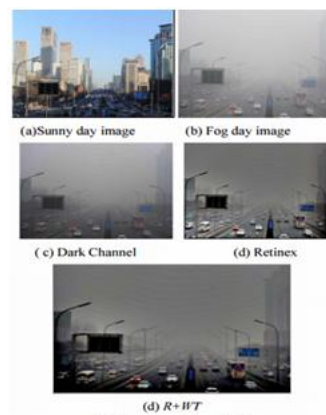


Fig1 Experimental result (1)

**Fig.2 shows another experimental result set, The means of (a)-(e) are same as part in fig.1**



Fig2 Experimental result (2)

**VI. EVALUATION AND DISCUSSION**

we consider use an objective method to evaluate the effective of fog removing. PSNR (Peak Signal-to-Noise Ratio) is the most common and most widely used objective measurement method for the image quality evaluation. In order to measure the image quality after a certain processing, we usually calculate PSNR value to measure this processing

method whether is satisfactory. PSNR calculation formula is

$$PSNR = 10 \cdot \log_{10} \left( \frac{(2^n - 1)^2}{MSE} \right)$$

$$MSE = \frac{\sum_{i=1}^n (p_i - p'_i)^2}{\text{frame size}}$$

Peak is refers to a maximum 255 of 8 bits representation. MSE (Mean Square Error) is the mean square error between original image and image processing. I (corner mark n) refers to the n pixels of original image; P (corner mark n) refers to the n pixel value of the processed image. The unit of PSNR is dB. In our experiments, we calculate the PSNR values of ten fog images respectively for Retinex, Dark Channel and R + WT method. The PSNR results are shown in the table 1 below.

| Picture name | PSNR of Dark channel | PSNR of Retinex | PSNR of R+WT |
|--------------|----------------------|-----------------|--------------|
| Picture 1    | 38.07                | 50.44           | 51.76        |
| Picture 2    | 38.1                 | 47.308          | 48.08        |

### VII. CONCLUSION

We propose A Novel fog-removing method which has combined the merits of Retinex algorithm and Wavelet transform, this proposed fog-removing method firstly use Retinex algorithm to enhance overall outline information of the image, then use wavelet image enhancement method to get high frequency information from the Retinex-ed image, finally a more cleared and fog-removed image can be obtained. We evaluated the proposed R+WT method by using objective evaluation. the proposed. R+WT method is better than other traditional algorithms such as Retinex, and Dark Channel. Overall, the proposed R + WT method is more suitable for the fog haze weather image enhancement; especially improve the processing effect on fog weather's vehicle detection and license plate recognition. Using R + WT method processing, we can not only restore the most of the image information, but also reduce the noise of the image, it will be more convenient in the subsequent image processing.

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